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TITLE: METHOD OF HANDLING CONTEXT DURING SCALING WITH A DISPLAY

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METHOD OF HANDLING CONTEXT DURING SCALING WITH A MAP DISPLAY

BACKGROUND OF THE INVENTION

The present invention relates to the presentation of map information on a display screen of a computing device, and more particularly, the present invention relates to a way to improve the presentation of map information on a display screen of a computing device when a user zooms in or out.

There are various computing platforms that graphically display maps of geographic areas. For example, some in-vehicle navigation systems include a display screen upon which a map of a geographic area can be displayed graphically. In addition, by using appropriate software applications, maps can also be displayed on general purpose computing platforms, such as personal computers and personal digital assistants.

Some computing platforms and applications that display maps graphically include features that allow a user to interact with the map. Various types of user interaction may be supported. Among the features that may be supported is the ability to zoom in or out. When a user zooms in on a map, a sub-portion of the originally displayed map is selected. The user may operate a pointing device for this purpose. Then, a new map is graphically displayed. The new map corresponds to the geographic area of the selected sub-portion of the originally displayed map. The new map is at a larger scale than the originally displayed map so that new map fills the same area on the display screen of the computing device on which the originally displayed map had been shown.

When a user zooms out on a graphically displayed map, the new map is at a smaller scale that the previously displayed map. The new map corresponds to a geographic area that is larger than the geographic area that corresponds to the previously displayed map such that the geographic area that corresponds to the previously displayed map is only a sub-portion of the geographic area that corresponds to the new map.

Maps shown at different scales on display screens may include different levels of detail. This is done in order to make it easier for a user to read and understand the

information presented on the map. For example, large-scale maps may include more detail (e.g., all the streets and other cartographic features may be displayed) whereas small-scale maps may include less detail (e.g., secondary streets and minor features may be omitted). If secondary streets and minor features were not omitted on a small-scale map, the display would contain so much information that a user may find it difficult to understand.

Because maps at different scales are associated with different levels of detail, a lower level layer of map information may become visible or disappear when a user is zooming in and out on a map. The sudden appearance or disappearance of an entire level of map information may sometimes be confusing to the user. In addition, geographic features may be represented differently at different levels of detail. For example, on a large scale map (i.e., a map with a high level of detail), a road on which the lanes are separated by a median may be represented by two separate lines —one line representing the lanes on one side of the median and the other line representing the lanes on the other side of the median. However, on a small scale map (i.e., a map with a low level of detail), a road on which the lanes are separated by median may be represented by only a single line. This change in the appearance of represented features that occurs when zooming in and out on a map can also be confusing to a user. For example, if an area or intersection changes shape significantly when the scale is changed, the user may lose his/her point of reference on the map, i.e., he/she may become unsure where on the map it was that he/she was viewing. This can lead to repeated zooms in and then out while the user tries to determine which roads and features remain the same across the transition between levels of detail.

Accordingly, there is a need for an improved way to represent map features when zooming in and out.

SUMMARY OF THE INVENTION

To address these and other objectives, the present invention comprises a method for representing geographic features when a map display is zoomed in or out. The method includes displaying a starting image that shows geographic features at a first scale with a first level of detail and then displaying an ending image that shows the same

geographic features at a second scale with a second level of detail. Between the displaying of the starting image and the displaying of the ending image, at least one intermediate image is displayed. The intermediate image combines two component images of at least some of the same geographic features shown in the starting or ending image. The two component images in the intermediate image are at the same scale and are registered with respect to each other so that the same geographic features represented in the two component images coincide. One of the two component images in the intermediate image includes at least a portion of the starting image and is formed using data from a first layer of a geographic database. The other of the two component images in the intermediate image is formed using data from a second layer of the geographic database.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a diagram illustrating a computing platform that incorporates an embodiment of a feature for a map display that provides context during scaling.

Figure 2 is a diagram of the database in Figure 1 and shows an arrangement for organizing the database into layers.

Figure 3 is an illustration of the display screen of Figure 1 with a first map image of a geographic feature displayed thereon.

Figure 4 is an illustration of the display screen of Figure 1 with an intermediate map image of the same geographic feature as shown in Figure 3 displayed thereon.

Figure 5 is another illustration of the display screen of Figure 1 with another intermediate map image of the same geographic feature as shown in Figures 3 and 4 displayed thereon.

Figure 6 is another illustration of the display screen of Figure 1 with yet another intermediate map image of the same geographic feature as shown in Figures 3-5 displayed thereon.

Figure 7 is another illustration of the display screen of Figure 1 with still another intermediate map image of the same geographic feature as shown in Figures 3-6 displayed thereon.

Figure 8 is an illustration of the display screen of Figure 1 with a final map image of the same geographic feature as shown in Figures 3-7 displayed thereon after zooming out to a desired scale.

Figure 9 is a block diagram showing components in an embodiment whereby data for providing context while scaling are downloaded from a server to a client platform.

DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EMBODIMENTS

I. Overview of computing platform and geographic database

Figure 1 shows a computing platform 10. The computing platform 10 may be an in-vehicle navigation system, a personal navigation system, a personal computer, a personal digital assistant, or other device. The computing platform 10 may be part of a network or may be a standalone device.

Associated with the computing platform is a geographic database 14. The geographic database 14 may be located locally with the computing platform 10 or may be located remotely from the computing platform 10. If the geographic database 14 is located remotely from the computing platform 10, the data in the geographic database 14 may be provided to the computing platform 10 via a network or other type of communications system. The network or other type of communications system may be wireless, land-based, or a combination of both wireless and land-based. The network may include the Internet.

The geographic database 14 includes data from which maps can be graphically rendered. Formats for organizing and accessing a geographic database that includes data from which maps can be graphically rendered are disclosed in U.S. Pat. Nos. 5,968,109 and 6,047,280, the disclosures of which are incorporated herein by reference.

Associated with the computing platform 10 is a program 18 that uses data from the geographic database 14 to render maps graphically on a display screen 12 of the computing platform 10. There are various ways to implement a program that uses data from a geographic database to render maps graphically. For example, ways to display maps using data from a geographic database are disclosed in U.S. Pat. Nos. 6,092,076 and 6,163,749, the disclosures of which are incorporated herein by reference.

As mentioned above, when displaying maps at different scales, it may be preferred to provide the maps with different levels of detail. In order to facilitate the presentation of maps at different levels of detail, data that represent geographic features may be organized into layers. Figure 2 is a diagram illustrating an organization of the geographic database 14 into layers. In the embodiment of Figure 2, the geographic database is organized into layers based on a rank associated with the represented features. The lowest rank (e.g., 0) is associated with those features that are represented only when the finest level of detail is desired. In the case of roads, the lowest rank may be associated with side streets and alleys. On the other hand, the highest rank (e.g., 4) is associated with the most important features, i.e., those that would be displayed even at the coarsest level of detail. In the case of roads, the highest rank may be associated with expressways and major arterial roads.

When data representing geographic features are organized into layers, the lowest layer (e.g., 0) includes data representing geographic features of all ranks (e.g., 0-4). A highest layer (e.g., 4) includes data representing geographic features of only the highest rank (e.g., 4). Each other layer includes only those data that represent those geographic features of the associated rank and higher ranks. For example, layer 2 includes data that represent geographic features having ranks 2, 3 and 4. Layer 2 excludes data that represents geographic features of ranks 0 and 1.

As shown in Figure 2, these layers can exist as separate collections of the geographic data. When a navigation function, such as map display, requires geographic data with a high level of detail, a lower layer is accessed and used. On the other hand, when a navigation function requires geographic data with a low level of detail, a higher layer is accessed and used.

In an alternative embodiment, layers can be implemented logically with a single collection of the geographic data. The single collection would include all the data of all the ranks, i.e., similar to layer 0 in Figure 2. When a navigation function requires geographic data with a low level of detail, geographic features having higher ranks are suppressed logically. The logical suppression of higher ranked data is performed using a software program.

II. Context during scaling feature

In accordance with a first embodiment, the map display program (e.g., 18 in Figure 1) implements a feature whereby a user is presented with context information when changing scale, e.g., zooming, with a map being displayed. This context information takes the form of one or more intermediate (or transitional) displays of map information between the original map display (i.e., the map being shown before the user initiates a zooming operation) and the final map display (i.e., the map being shown when the zooming operation is completed). Each intermediate display of map information includes at least portions of two separate layers of map information. The data from these two separate layers of map information are on the screen at the same scale at the same time and overlaid so that the represented features coincide. In at least one of the intermediate displays, the two layers of map information include the layer used for the original map display. The other layer may be the layer used for the final map display, or if there are one or more layers of map information with levels of detail between the level used for the original map display and the level used for the final map display, the other layer included in the intermediate display with the layer used for the original map display may be one of these intermediate layers. By showing an intermediate image that includes both the original map data and data from another layer (either the layer used for the final map display or another layer between the layer used for the original display and the final display), the user is better able to observe the relationship between the original map display and the final map display.

In one embodiment, at least one intermediate image is provided for each transition between adjacent layers when zooming. For example, if a user zooms from a map display formed using data from layer 0 to a map display formed using data from layer 4, there are four intermediate images. A first intermediate image shows at least portions of layer 0 and layer 1 at the same time, a second intermediate image shows portions of layer 1 and layer 2 at the same time, a third intermediate image shows portions of layer 2 and layer 3 at the same time, and a fourth intermediate image shows portions of layer 3 and layer 4 at the same time. In an alternative embodiment, some of these intermediate images may be omitted or combined. For example, an intermediate image may be formed using data from three separate layers at the same time.

Each intermediate image of map information includes component images formed from portions of at least two separate layers of map information. The component images are on the screen at the same scale at the same time and overlaid so that the represented features coincide. In at least one of the intermediate images, the two layers of map information include the layer used for the original map display.

In order to improve presentation of the map information in an intermediate image when data from two separate layers are on the screen at the same time, the data from one of the layers may be presented at a reduced level of color saturation (e.g., a percentage grayscale) or with a level of transparency. For example, if an intermediate image includes data from layer 0 which had been used for the original map display and data from layer 1, the data from layer 1 may be shown at 50% color saturation (e.g., 50% grayscale). If several intermediate images are presented for this transition (i.e., layer 0 to layer 1), each successive intermediate image would show the layer 0 data with lower levels of color saturation (e.g., 100% to 60% to 20%) while the color saturation of the layer 1 data would increase in each successive intermediate image (e.g., 20% to 40% to 60%).

According to another alternative, the intermediate displays may include both decreasing levels of color saturation (or increasing transparency) for the data obtained from one layer and increasing levels of color saturation (or decreasing transparency) for data obtained from the successive layer. Using any of these alternatives, a gradual fading effect can be implemented. According to another alternative, the intermediate images can be more gradual to increase the fading effect.

Example

An example of an implementation of an embodiment of the map display feature that provides context during scaling is shown in Figures 3-8. Figure 3 shows an illustration of a geographic feature on the display screen 12 of a computing platform (10 in Figure 1). The geographic feature is a complex highway interchange. The illustration in Figure 3 is rendered using data from the geographic database (14 in Figures 1 and 2). The data used to form the map display of Figure 3 is obtained from layer 0 of the geographic database (14 in Figures 1 and 2). In the illustration in Figure 3, there are

some rank 0 roads and ramps, a rank 1 road crossing east-west, and a rank 3 double digitized highway. In Figure 3, the data representing this complex interchange is shown at a scale that is zoomed in far enough to see everything. All the roads are present and fully visible.

When the image of Figure 3 is being displayed on the display screen 12, the user implements a zooming operation, e.g., zooms out. The user may initiate the zooming operation by manipulating the user interface of the computing platform (10 in Figure 1). For example, the user may use a pointing device, such as a mouse, to select an area on the display and indicate that zooming out is desired. When the user initiates the zooming operation, the program 18 obtains data from the geographic database 14 that corresponds to the same geographic area, but at a smaller scale.

Figures 4-7 represent successive intermediate map images and Figure 8 represents the final map display, i.e., the map image at the scale desired by the user when zooming out is fully completed. In Figure 4, a first intermediate image shows layer 0 and layer 1 data. The layer 0 data and the layer 1 data are on the screen at the same time. The layer 0 data and the layer 1 data are adjusted to the same scale and registered with respect to each other so that the same features represented by each layer coincide (or overlap). The layer 0 data is shown at a 50% color saturation (50% grayscale) and the layer 1 data is shown at full color saturation (100% black).

Figure 5 shows a second intermediate image of the same geographic feature (i.e., the intersection). The image in Figure 5 is displayed after the image of Figure 4. The image of Figure 5 is zoomed out even farther from the image in Figure 4. Layer 0 data is now present only at 20% grayscale.

Figure 6 shows a third intermediate image of the intersection. The image in Figure 6 is displayed after the image of Figure 5. The image of Figure 6 shows the intersection zoomed out to where layer 2 is the presentation layer at this scale. The only layer 2 information corresponding to this feature is the two lines of the double digitized highway. According to this embodiment, the layer 1 road running east-west is shown in 50% grayscale. This helps the map user retain an idea of where on the highway a point is. The user can relate a location to before or after the overpass. At this scale, the generalized layer 3 version of the highway in gray is beginning to appear. This prepares

the map user for the scale at which the two lines representing the highway will turn into a single line.

Figure 7 shows another intermediate image. In the intermediate image shown in Figure 7, data from layer 3 shows the highway as a single line. This data from layer 3 is shown at 100% color saturation. The intermediate image shown in Figure 7 also includes data from layer 2 that shows the highway as a pair of double lines. The data from layer 2 is shown at 50% color saturation and appears in the intermediate image of Figure 7 as thin gray borders.

Figure 8 shows the final map display with the image of the geographic feature fully zoomed out to the scale desired by the user. In Figure 7, the highway is shown as a single thin line with 100% color saturation using only data from layer 3.

III. ALTERNATIVES

A. Scalable Vector Graphics (SVG)

Scalable Vector Graphics (SVG) is a proposed standard for web graphics that is being developed by the W3 consortium. SVG envisions a graphics file format with multiple layers of graphics that are developed from polygons, similar to Macromedia Flash or Postscript graphics. Animation is possible with JavaScript code that is part of the graphics file. Transparency of graphics elements are also part of the SVG model. Support for SVG may be included in future browsers, much like support for JPEG and GIF is today.

One of the applications for the SVG format is the display of maps. SVG provides the ability to download maps (as vectors) that can be zoomed and possibly panned without further interaction with the server, at least until more data is needed. Although the SVG format may be helpful for displaying some maps, the SVG format has some limitations. An SVG map with full layer 0 detail for a geographic area, along with context higher level information, would look very cluttered in the detail area when zoomed out. Such a map may also be slow to display. In addition, the display may include detail that is too small to see. These difficulties can be addressed using an embodiment of the disclosed map display feature that provides context during scaling.

According to one embodiment, a user operates a client-computing platform to request data from a server for a map of a location. The user may access the server over a network, such as the Internet. The user requests the data in a vector format (such as SVG). The server sends the user a file that contains multiple layers of data. The file would be about four times the size of an SVG map that only showed the data for a single layer at one scale. On the client computing platform, the user uses a viewer capable of viewing smooth scale changes, such as a SVG viewer, to view the downloaded data as a map image. Included with the downloaded file would be a routine or script that could be used in the SVG viewer to adjust layer transparency depending upon zoom layer. The routine or script may be written in JavaScript code, for example. Figure 9 illustrates components used to implement this embodiment.

According to another embodiment, a user operates a client computing platform to request data from a server for a map of a route. The server sends the user a file that contains multiple layers of data for forming a map for the route. The map for a route includes a nesting set of strip maps centered around the route. Each layer included in the downloaded file would show an area around the route appropriate to the display scale of the layer. As described above, the user uses a viewer, such as an SVG viewer, to view the downloaded data as a map image. The user could zoom in and out of the route, pan along the route and save the downloaded file to transfer to another computer.

Using these embodiments, a user can download a map file that will look attractive at any scale. By using the context during scaling feature, the user may find the map data easier to use and understand when performing a zooming operation.

B. Smooth zooming versus discrete stages zooming

As stated above, when a user operates the map display for a zooming operation, the scale of the map changes. The map scale may change in discrete stages or alternatively, the map scale may change gradually, i.e., in stages so small that it appears to the user to be smooth. Embodiments of the context during scaling feature can be used with zooming that occurs in discrete stages or smoothly.

C. Alternative file formats

It was mentioned above how embodiments of the map display feature that provides context during scaling can be used with vector formats, such as SVG. Embodiments of the map display feature that provides context during scaling can also be used with other file formats, including static formats like JPEG or GIF. If a map is provided in a file format, such as a GIF file format or a JPEG file format, the map can be displayed with an appropriate viewer for such a format. A routine included with the downloaded data would provide for displaying the images over one another with the appropriate transparency.

D. Alternative colors

In some of the embodiments described above, when data from two different layers are shown at the same time on the display screen, the data from one of the layers is shown at a reduced level of color saturation. In some of the embodiments, this reduced level of color saturation is a shade of gray. However, the display of geographic features is not limited to black or gray. In alternative embodiments, the geographic features can be shown in any color, such as blue, red, etc. Geographic features shown in these colors can be shown with reduced levels of color saturation (or transparency), as appropriate, when shown in intermediate images with any of the above described embodiments.

IV. ADVANTAGES

The disclosed embodiments provide several advantages. According to the disclosed embodiments, different layers of data can be scaled to appropriate levels of accuracy on the server. When these data are downloaded to a client platform, the data are displayed only within appropriate ranges of scales. In this way, the data are not displayed with unintelligible detail or large overly heavy lines. Each layer can have its own scaling equation.

It is intended that the foregoing detailed description be regarded as illustrative rather than limiting and that it is understood that the following claims including all equivalents are intended to define the scope of the invention.